

Or, under specific conditions, ice kernels form within the earth. These ice kernels grow and press the upper layers of the earth into a hill, which then in the warm season collapses again. As a result a lake is frequently formed in place of the hill because of break-throughs in the earth. Generally the existence of frozen earth permits the absorption of the surface water only to a certain depth, and accordingly the rainfall for the most part must flow off on the surface. The irregular water flow of the rivers in these regions often goes back to this phenomenon. Thus the contrast between the high and low water lines is very great everywhere. At the confluence of the Shilka and the Agrun, the Amur passes, as its annual mean 1,200 cubic meters of water per second, while the minimum during the year is only 125 cubic meters per second. Heavier rainfall makes itself felt immediately in an often flood-like rise in the water being passed in the rivers. The thawing of the surface layers of the earth, especially in areas with varying morphological formations, offers the best conditions for ground flows. Thus the domain of the permafrost is the classical land for landslides and solifuction.

But, in addition to these numerous and very interesting natural phenomena, the effects of the permafrost on man and his economy must be mentioned; these effects are apparent everywhere in the permafrost domain and often bring difficulties. Through freezing the volume of the water expands, presses the ground upward in places, and causes destruction of transportation installations. Deep tears occur in the railroad line, and through these tears mud and water from deeper layers often push out. /53/ /Map of the permafrost area:/ /54/ freezes on the surface, bursts the splits open farther, and forms high bucklings, and thus gradually the roads become unusable. With the setting in of the thawing weather, everything sinks together in mud and pulp.

In addition the roads and especially the bridges are by preference the starting points for ice building on ice. As an example Sumgin points out the road built from Bol'shoy Never on the Amur railroad, via Tyndinsky and the Aldan gold region, to Yakutsk on the Lena. This road should be usable for trucks the entire year. Out of the entire length of 1,300 kilometer, on the southern part alone between Bol'shoy Never and Tommot, which is 728 kilometers long, 117 formations of ice on top of ice were counted in the winter of 1927-28. These formations caused serious destruction, especially on bridges which were as a result partially raised up, made crooked, and gradually

132
134132
134
499

[491]

132 made unusable. In the spring after the melting away of the ice, the
134 bridges completely collapse. The population claims that earlier for-
499 mations of ice on ice occurred only seldom in these same regions.
Thus it must be assumed, and Sumgin also points this out, that the
formations of ice on ice are encouraged by the building of roads.
Through trials and experience, various new methods of road-building
have been found which hinder this damage, but it can not be entirely
eliminated. In general terms it can be said that in the areas of per-
mafrost road-building is very difficult, requires a longer time, and
is done at much greater cost than in other regions.

Of a similar type are the difficulties encountered in building
and maintaining railroad lines. In addition to the pulsation of the
earth, landslides and solifluction are regarded as being especially
dangerous here. In building the Amur railroad line all these hindrances
and difficulties became known in detail. Often, without regard to the
cost, the lines had to be laid entirely differently from what had ori-
ginally been planned. Especial difficulty was encountered in providing
water for the railroad in the winter in the areas of permafrost. Water
had to be drilled from layers which lay under the permafrost. In many
places water had to be procured in kilometer-long, heated conduits.
A comparison of costs shows best how great the difficulties were in
building the Amur railroad line in the areas of permafrost and to what
extent these difficulties increased the costs here versus those in other
regions. The building of the great Siberian Railroad (as far as Sretensk
in Transbaykal), including all preparatory work, required as a mean
an expenditure of 67,737 rubles per verst, while the western part of
the Amur line from Kuenga to Kerak, whose total length is 597 verst,
required for pure building costs an average expenditure of 158,000
rubles per verst. Also the maintenance of the railroads requires larger
outlays, since the railroad lines, and especially the bridges, require
constant and very careful inspection, in order to be able to take /55/
protective measures in time at the slightest sign of any destruction
whatsoever. Thus in the course of the year position changes were
determined on 50 out of a total of 80 bridges on the Amur railroad,
and these position changes had to be eliminated by protection and
rebuilding measures.

132 The permafrost also plays a noteworthy role in the method
134 of construction. Apart from the direct effects of the cold, the buildings
342 in the sphere of the permafrost are subjected to the danger of gradual
decay. The reason for this lies principally in the fact that the ground

substitute line, which is put into action immediately if the first rail- 496
road line is disturbed for any reason. This was the case during the
period of Japanese rule in Manchuria from 1931 to 1945. It was during
this period that the pressing necessity of a second track for the eastern
part of the Trans-Siberian Railroad first arose. The second track for
the stretch from Ulan-Ude to Urusha (1,570 kilometers) was laid from
1933 to 1935; the stretch from Urusha to Khabarovsk (1,314 kilometers)
was laid from 1934 to 1936; and the stretch between Khabarovsk and
Vladivostok (768 kilometers) was not laid until 1938 to 1939. The
North Manchurian Railroad, on the other hand, was built with two
tracks from the beginning. Of greatest importance is the fact that the
Russian track width was not changed in Manchurian territory from 1931
to 1945, and, accordingly, the railroad line was available for the use
of the Soviet Union immediately after the end of World War II. In
the period from 1905 to 1945 the Japanese changed only the South
Manchurian Railroad (Harbin to Dairen) to the Japanese track width
(normal tracks), while the North Manchurian Railroad was always
traveled by Russian locomotives and Russian railroad cars.

The construction of the Transbaykal Railroad began in 1895 497
and was supposed to be completed in 1898. However, a flood, such
as Transbaykal had never experienced, caused such extensive damage
that it was only in 1900 that traffic could cover the entire stretch.
Construction of the line was very difficult. The ground in Transbaykal
is permanently frozen and thaws in the summer only to a depth of one
to two meters. As a consequence of this, the work had to be done
during the warm part of the year with dynamite under the thawed out
layer of earth; this turns the thawing masses of frozen earth into a thick
porridge /Brei/. The installation of water conduits was especially
difficult. In order to prevent freezing, the water pipes had to be laid
in wooden galleries which could be heated. Since according to the
construction specifications only Russian materials could be used, these
materials had to be procured in part via Vladivostok and Khabarovsk.
For this purpose state shipping was established on the Ussuri, Amur,
and on the Shilka as far as Sretensk. This resulted at the same time
in a permanent opening-up of this waterway.

The section from Sretensk to Khabarovsk was originally en-
visaged as a continuation of the Transbaykal Railroad to the east. The
marking /185/ out of this line, however, pointed up such great diffi-
culties and such unfavorable economic conditions that this plan was

• 499 abandoned and it was decided to build the railroad from Transbaykal to Vladivostok across Manchuria. Negotiations with China led in 1896 to a concession to the Russo-Chinese Bank for the construction and management of a railroad through Manchuria; this railroad received the name of East Chinese Railroad. The East Chinese Railroad Society, founded on the basis of this concession, received the right to manage the railroad for eighty years after the opening of the line. After this period the railroad was to fall to China without compensation. The society was further required to construct a connecting railroad from the eastern border of Manchuria to Nikol'sk-Ussuriski, the present day Voroshilov, and also to erect a railroad line from Harbin to the ice-free south Manchurian harbors of Dal'nyy and Port Arthur. The main line from Manchuria to Grodekovo was begun under Russian direction in 1897 and was completed in 1904. The completion was delayed so long because the rebelling Chinese in the Boxer Rebellion of 1900 completely destroyed approximately 950 kilometers of the 1,350 kilometers completed. The result of this was the occupation of Manchuria along the main lines by Russian troops, which remained until 1904-1905, and, consequently, the Russo-Japanese War could be fought out on Manchurian territory.

The construction of the last part of the Trans-Siberian Railroad between Vladivostok and Khabarovsk occurred before the completion of the Amur Railroad. The construction of the southern half began in 1891 and was completed in 1894; the northern half was completed from 1894 to 1899. The resolution of the labor question was especially difficult here in the regions still little populated. As with the Transbaykal Railroad, this problem was alleviated by the use of military detachments, prisoners, and forced settlers.

There was the longest hesitation on the construction of the Amur Railroad. The inexact knowledge of the land, the vast uninhabited areas, the unfavorability of the climatic and soil conditions, and the great length of approximately 1,500 kilometers were discouraging. Decisive for the decision was the outcome of the Russo-Japanese War. In 1908 construction was begun on partial stretches, and only in 1916 was the entire stretch open to traffic. Here, too, permafrost was one of the greatest difficulties. Heaped up railroad embankments melted away often and breaks in the ground were filled up again and again by solifluction. Water had to be drilled from layers which lay under the frozen earth. The strict specification, which applied here, too, that only Russian workers and no yellow-skinned assistants were to be used

in the construction, attained brilliant results not only because many millions of rubles remained in the country but also primarily because it fostered colonization. Many thousands of workers, who were recruited from Russia, learned to know the Amur country and settled in the land after the completion of the construction.

499°

[167]

/186/ The Trans-Siberian Railroad leads through the most important localities in the Far Eastern region. The distances between the most important localities are as follows in railroad kilometers: Irkutsk--Ulan-Ude, 490 kilometers; Ulan-Ude--Chita, 554 kilometers; Chita--Khabarovsk, 1,428 kilometers; Khabarovsk--Vladivostok, 768 kilometers; Karymskoye--Otpor (border station), 366 kilometers; Karymskoye--Harbin--Vladivostok, 1,981 kilometers.

496

A number of branch railways lead from the main line to localities which are important economically or in terms of transportation. On the Transbaykal Railroad and the Amur Railroad the following, from west to east, are to be cited.

Ulan-Ude	--Naushki (Mongolian border)	225 kilometers
Petrovsk	--Balyaginsk (iron ore)	19 kilometers
Tolbaga	--Khalyarta (coal)	8 kilometers
Ingoda	--Ildigun (wood, agriculture)	52 kilometers
Priiskovyy	--Nerchinsk (city connection)	10 kilometers
Kuenga	--Sretensk (Shilka harbor)	55 kilometers
Pashennaya	--Bukachacha (coal)	73 kilometers
Skovorodino	--Dzhalinda (Amur harbor)	60 kilometers
Ushumun	--Chernyaye (Amur harbor)	38 kilometers
Kuybyshevka	--Blagoveshchensk (Amur harbor)	109 kilometers
Bureya	--Raychikhinsk (coal)	43 kilometers
Arkharu	--Innokent'yeva (Amur harbor)	35 kilometers
Izvestkovyy	--Ust'-Tyрма (coal)	190 kilometers

Of these lines the railroad from Ulan-Ude to Naushki is of the greatest significance. It was completed in 1939 and leads to the Mongolian border. Since then it has been lengthened to reach Ulan Bator (Urga), the capital of the Mongolian People's Republic. Then, in addition, various side lines have been created in the last few years. Thus a railroad line leads from Skovorodino over 150 kilometers to Tyndynskiy in the area around the upper course of the Gilyuy, and there is supposed to be a connection to the new Baykal-Amur Railroad (BAM). Also the Izvestkovyy--Ust'-Tyрма line named last in the above list